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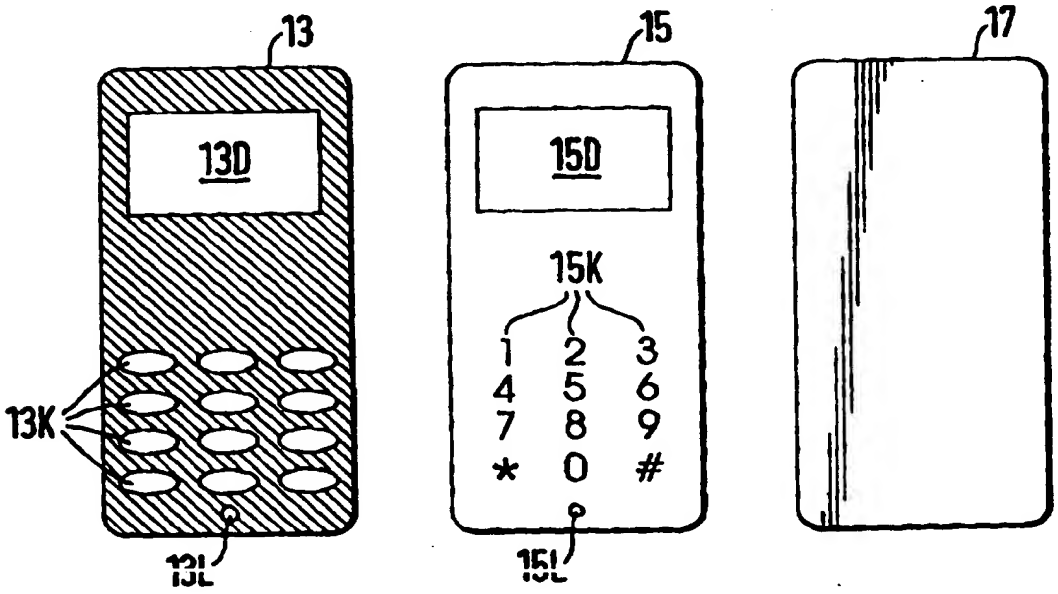
(54) Title: SHIELDING RADIO EQUIPMENT



(57) Abstract

A mobile telephone handset (10) has a surface (10F), which includes operating keys and display (not shown), covered by multi-layer absorptive and reflective radiation shielding (11). The shielding (11) comprises: radiation-absorptive layer (13) next to the handset surface (10F) and having apertures in register with operating keys and displays; radiation reflective layer (15) next to the absorptive layer (13); and outer protective transparent layer (17) shown continuous over the reflective layer (15).

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TITLE: SHIELDING RADIO EQUIPMENT

DESCRIPTION

TECHNICAL FIELD

The invention has arisen in relation to shielding high-frequency, typically micro-wave, radio equipment such as mobile telephone handsets.

BACKGROUND ART

There is concern about possibly adverse effects of radiation, typically in the region 850 Mhz to 1.8 Ghz, from mobile telephone handsets on users' face and head tissue, including the human brain. Standards relating to heating effects of microwave radiation reaching the head vary from country to country. We are aware of several prior proposals involving protective shielding of external antennae of mobile telephone handsets at positions interposing shielding material between such an antenna and

the user's head. Other prior proposals involve shielding applied internally of the handset, basically involving application of similar rationale to internal antenna provisions and extending it to transmission drive electronic circuitry. Yet other prior proposals concern handset-accommodating boxes, cases or pouches made of shielding material, generally including extending such material to external antenna.

Radical re-evaluation of potential problems, in the context of achieving satisfactory operation of mobile telephone handsets, has led to an object of this invention by way of making more rational and advantageous shielding provisions.

Elements of our re-evaluation include appreciating that, in use, an external antenna of a mobile telephone handset is actually more remote from the user's head than the handset body as such; that the previously proposed external antennae shielding so reduces radiated signals as to detract unsatisfactorily from design criteria for operation of such handsets; that fully effective internal shielding is not as readily retro-fitted as some prior proposals appear to assert or assume; and that, in use, additional housing boxes, cases or pouches inevitably so increase bulk and reduce ease of operation of handsets as to counter basic structural and ergonomic design criteria, particularly as to lightness and compactness.

DISCLOSURE OF INVENTION

According to one aspect of this invention, radiation

shielding for such as mobile telephone handsets is limited to externally affixed laminated shielding material having an inner layer of radiation-absorptive nature and apertured in register with operating keys, buttons, pads, membrane, etc; and a layer of radiation-reflective material that extends over the inner layer and its aperturing but allows required operation by touch over said aperturing.

Normally, the inner radiation-absorptive layer will be thicker and/or less flexible/deformable than the radiation-reflective layer and/or opaque, hence its aperturing, which can extend to registration with display(s) of the handset; and the radiation-reflective layer is preferably transparent, thus allowing sight of original marking(s) of operating keys etc. markings and/or display(s). However, an opaque radiation-reflective layer could be used if itself marked over said aperturing of the radiation-absorptive layer and operating keys etc. of the handset, whether with or without additional transparent material at window(s) registering with display(s). This latter possibility might appeal most to a handset manufacturer, perhaps preferably feasibly with appropriate radiation-absorptivity provision incorporated directly into the handset casing as such.

According to another aspect of this invention, radiation shielding for such as a mobile telephone handset comprises radiation-reflective material that is applied over radiation-absorptive material, including over operating keys, buttons, pads, membrane, etc. and whether

or not the absorptive material is additional to or incorporated in equipment casing provision.

The radiation-reflective layer may itself be of laminated form, for example an actually reflective inner or under layer and an outer covering or wear layer as may be desired or required.

Suitable radiation-reflective materials include flexible polymer plastics films with reflective properties for the radiation concerned, conveniently by way of thin metallic coating that need not obstruct optical transparency where that is desired or required, and can readily present desirable heat and electrical conductivity, advantageously as an area resistance in the range about 10 to 30 ohm/square. Indium tin oxide is a preferred reflective coating satisfying such requirement at reasonable cost with particularly operationally satisfactory and aesthetically pleasing results, including as compared with alternatives such as silver or gold. Suitable processes/techniques for metallising include physical vapour deposition (PVD) of evaporative or sputtering type and fit-jet spraying of a liquid carrier medium. Reflective coating, of whatever effective nature, can be to one side only of the film, conveniently and advantageously its inner or under surface, typically after application thereto of colouration and/or graphics and/or printing to be visible through transparent said film; though such could use marking materials, such as ink(s) etc. that have relevantly reflective ingredients, normally

metal(s), or even simply be transparent to radiation concerned, thus applicable over metallising if desired. The outer surface is preferably suitably surface-treated or textured, typically coated or UV treated, so as to improve its appearance and/or tactile properties, e.g. to be less shiny and/or slippery to touch.

It is preferred that the flexible plastics film be as thin as will be serviceable, including regarding localised deformation(s) as required to operate keys etc. see further later regarding, but not to be taken as limited to retrofitting to existing models of mobile telephone hand-sets. Suitable transparent plastics film includes readily available bi-axially oriented polyester, typically of about 150 microns thickness and tensile strength/elasticity consistent with an initial tear factor of about 60% to about 165%. Other feasible plastics film materials include polyvinylchloride (PVC).

Suitable radiation-absorptive materials include a host of polymerised synthetic resin (plastics), such as PVC, with various inclusions contributing to energy conversion and effective absorption of electro-magnetic radiation concerned, i.e. at frequencies of interest. Inclusions include such as metals, metal oxides, ferrites; carbon (say some form of graphite), boron, silicon, mica, ceramics; and rare earth elements, generally in particulate or powdrous, fibrous (usually chopped) or flake form combining to meet design requirements for absorption, typically including as to electrical conductivity in similar range to that above

for metallisation of the reflective layer assuring desired radiation insertion loss preferably of the order of at least 45 decibels, relative to frequencies of radiation concerned. Such absorptive materials are readily procurable from various specialists in the field, typically with a predominance of carbon in various particulate and/or fibrous and/or flake forms, perhaps preferably all such forms. Energy conversion effects concerned include direct absorption generating heat, phase-shifting say to produce useful degrees of cancellation of incident radiation, at least localised generation of electric current flow(s) dissipating into the host material as heat if not taken off to ground.

A foamed or expanded plastics host material can be advantageous, typically of closed cell form with its cell size(s) generally greater than about 0.001mm and less than about 0.01mm, or of open cell form with its pore size(s) generally between about 0.01mm and about 0.1mm. Typical thickness of a layer of the radiation absorptive material, i.e. the host material, is from about 0.65mm to about 1.7mm, giving satisfactory bulk without undue mass. Typical sizes for inclusions range from about 45 microns to about 150 microns for particles; of the order of 0.007mm, say about 0.005mm to about 0.010mm diameter and about 0.5mm to about 1mm length for chopped fibres; and of the order of 0.0025 micron, say about 0.0015 micron to about 0.004 micron, for flake, such as of colloidal graphite.

It will be appreciated that reference to "reflective"

and "absorptive" is by way of predominant action, i.e. not ruling out each material having some of each action, so long as there is not enough reflection by the absorptive material adversely to affect operation of such as a mobile telephone handset, and amount of absorption by the reflective material is not enough the cause significant heating. Combined shielding effects for composites of absorptive and reflective layers hereof have been measured as exceeding 80%.

Absorptive layer material is of relatively high cost, and many mobile telephone hand-sets have main radiating components localised so that, strictly speaking, less than full coverage is required for its surface concerned by such absorptive layer, though can still benefit from coverage by the reflective layer, which in any event, is desirably substantially continuous over the whole of such surface. Often, the area that need not be so covered is in/about the region of the keys to be operated through the reflective layer, typically at aforesaid hollow stud-like deformations usually inwardly formed. Generally, preferred embodiments hereof can have other than absorptive material underlying the reflective material at such areas, preferably of a resilient or cushioning nature and/or equivalent to the absorptive layer in such respects. Indeed, this other material can be of substantially matching thickness to that of the absorptive layer or at least conforming reasonably therewith but perhaps different for other reasons, such as generally minimising or optimising materials usage and/or

consistency with requirements arising from protrusion of the operating keys and/or preferred deformation of the reflective layer related to operating the keys. In the latter case, or for use about display areas, this other material layer would, of course, be suitably apertured. Most telephone hand-set surfaces concerned have convexity, at least at and adjacent corners made with sides, and use of these other materials can be highly advantageous in accommodating thereto, particularly as to overall appearance and installed presentation of the reflective layer and any outer protective layer. Suitable materials include solid adhesive sheet or foam, usually acrylic and of thickness between about 25 microns and about 65 microns.

Practical embodiments of this invention as products to be retro-fitted to mobile telephone handsets may be unitary laminations, or may be in two or more parts, not all of which may necessarily include an absorptive layer of the same extent as the reflective layer. However, there will normally be at least some pre-lamination for such products, involving suitable adhesive, along with affixing adhesive provision normally under removable barrier sheet material for attachment to the conventionally front surface of the handset concerned, usually only to that surface. Either or both of such laminating and affixing adhesive(s) can be selected or subject to inclusions for properties useful to the purposes hereof, whether of desired transmissive or absorptive or reflective or dielectric nature; and would be additional to slight improvement of adhesive at incidence

and as inter-layer.

In tailoring particular retro-fitting embodiments hereof to corresponding mobile telephone handsets, there may be difference(s) of level(s) between handset operating keys etc and the reflective layer. These are preferably and advantageously accommodated or matched by way of localised inward or outward formations of the reflective layer to give hollow stud effective in register with the operating keys etc and corresponding aperturing of the absorptive layer and affording well-defined localised flexibility of tops such stud formations. At least where the apertured absorptive layer is thicker than upstand of the operating keys etc, an alternative is for spacers to be provided above each such key etc, preferably suitably attached or integrated with the reflective layer. Such spacers can be transparent, or opaque and suitably marked (unless overlying reflective layer is marked), say particular preferably die-cut from absorption layer material.

It will be appreciated that integration of teaching hereof into actual manufacture of such as mobile telephone handsets extends naturally beyond adding a full lamination of absorptive and reflective layers, particularly to at least some of absorptive inclusions being made to at least the front of the casing as normally being a moulded article and then perhaps only requiring adding on of a reflective layer substantially as taught herein.

BRIEF DESCRIPTION OF DRAWINGS

Specific implementation by way of practical embodiments of this invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which: -

Figures 1 and 1A, B C show an outline sectional view as installed and outline plan views of absorptive, reflective and protective layers, respectively;

Figures 2A and B show plan views of wholly or partially absorptive and reflective layers having matching cut-outs and localised deformations individually for each key, respectively;

Figures 3A and B show similar views for variant cut-outs and localised deformations related to groups of keys;

Figures 4 is a scrap outline sectional view showing individual key spacers/inserts; and

Figures 5A and B show outline plan and exploded side views, respectively, for an opened flip cover type of mobile telephone hand-set.

BEST MODES FOR CARRYING OUT THE INVENTION

Referring first to Figures 1 to 4, a mobile telephone hand-set 10 has surface 10F for operating keys and display (neither shown) covering by multi-layer absorptive and reflective radiation shielding 11 embodying this invention. Specifically, the shielding 11 comprises radiation absorptive layer 13 next to the hand-set surface 10F and having apertures or cut-outs 13K and 13D in register with

operating keys and display, respectively, of the hand-set 10; radiation reflective layer 15 next to the absorptive layer and shown carrying markings 15K in register with said operating key-related apertures or cut-outs 13K in the absorptive layer 13, to identify those keys, and with an aperture or cut-out 15D in register with said display-related aperture or cut out 13D; and outer protective transparent layer 17 shown continuous over the reflective layer 15.

The sectional view of Figure 1 is illustrative only. i.e. not drawn to scale for thickness of the shielding 11 and its constituent layers 13, 15 and 17, including the latter not relative to each other. The radiation absorptive layer 13 will be generally as discussed above, typically of sponge-like material with appropriate inclusions rendering it radiation absorptive, including appropriately electrically conductive. The radiation reflective layer 15 will also be as generally discussed above, generally much thinner web or film typically metallised to render it radiation reflective, including appropriately electrically conductive. The protective layer 17 may be thinner still, or even an appropriate coating for the reflective layer 15 for wear and/or contamination resistance.

As will readily be appreciated, the reflective layer would not need to carry the markings 15K, nor have the cut-out 15D if it was transparent, including through its metallisation. There are clearly advantages in

transparency, but opacity is both feasible (with said markings 15K and aperture 15D and would permit a wider choice of sheet material to be metallised (including opaque) and metal used in metallising (including opaque such as aluminium, or of less attractive hue than preferred indium-tin oxide).

Assembly together of the absorptive and reflective layers 13 and 25 can be aided, perhaps particularly as to required or desired registration by one or more sets of cooperating formations, see, by way of example small aperture 13L in the absorptive layer 13 and indication at 15L of a registering pip formation of the layer 15, say formed by deformation inwardly of the plane of the drawing.

Operating of the hand-set 10 will be as normal, but with its keys operated indirectly through and by touch applied locally to the reflective layer 15.

For fitting to the hand-set 10, the shielding may be a pre-laminated composite, preferably complete with an adhesive over part(s) if not all as is preferred of the available absorptive layer 13, say with a barrier or cover layer to be removed for fitting purposes. Progressive application of some or all of the layers 13, 15 and 17 is not to be ruled out, even if less attractive and easy for user-application as a retro-fit product. Adhesive between the protective layer 17 and the reflective layer 15 will, of course, be transparent, though that between the layers 13 and 15 need not be transparent unless the reflective layer 15 is transparent, nor need the adhesive on the other

surface of the layer 13 be transparent. A wide range of choice applies to adhesive, even as required or desired to be transparent, including acrylics.

Figures 2A, B show two-layer-only shielding, i.e. with the reflective layer 15 not needing any additional protective layer as discussed above, and as applies to illustration of all further embodiments. There is similarity to what has just been described in that radiation absorptive layer 23 has individual operating key and display-related apertures or cut-outs 23K and 23D, but also differences in that the absorptive layer is shown in two parts 23A, B and the radiation reflective layer 25 is transparent (thus needs no operating key-related markings) and further requires no additional protective. Either of the two parts 23A, B may by omitted or replaced by non-absorptive layer material if radiation-producing components of the hand-set concerned are localised and concentrated at positions under the other part, as generally discussed above.

Moreover, the layer 25 is shown (by shading) with deformations 25K and 25D out of its main generally flat planar form in registration with operating key- and display-related apertures or cut-outs 23K and 23D of the layer parts 23A, B. Usually, but not necessarily, depending on the relation between upstand(s) of operating key(s) and thickness of part 23B, the deformations 25K will be outwards and slightly but sufficiently larger for any thus- required accommodation of actual operating keys and

their operation. The deformation 25D may also be outwards, though it could (and perhaps even preferably) be inwards depending on thickness of the layer part 23A unless not present, and is shown in a greater outward deformation 25A representing matching to the layer part 23B being absent or of lesser thickness than the layer part 23A. A modification of the layer part 23B, say where the operating keys less spaced, could involve at least some of the apertures or cut-outs 23K being coalesced into row or column-like apertures or cut-outs, or even further into one or two more rectangle-like apertures or cut-outs. All of these differences and further differences as and when further noted are to be considered as individually applicable options, so far as makes sense.

The embodiment of Figure 3A, B differs as to overall shapes of the layers and parts 33A, B and 35, and as to extensive coalescence aperturing 33K, and as to the deformations 35X, Y being larger to register with groups of the operating keys.

Turning to Figure 4, another variation is shown where part of apertures or cutouts 43K in the layer 43 (or layer part 43B) above operating keys 40K through associated hand-set wall 40 is occupied by spacers 49, usually of plastics material, say transparent to allow sight of the keys 40K, or opaque and marked corresponding to the keys (then feasibly of absorptive material). This can improve immediacy of operation of the keys 40K through the reflective layer 45, which is shown unreformed over the

keys 40K, though that is not necessarily so as combination of such deformation and spacers 49 could be displayed if desired.

Figures 5A, B show application to hand-set 50 of so-called "flip" type shown with a much greater step between its display part 50A and its operating key part 50B to accommodate a hinged cover 50C for the latter, and ear-piece socket/microphone provisions 58E, M. Shielding hereof is indicated by way of two shielding parts 51A, B over the display and operating key parts 50A, B - see absorptive layer part 53A only, solid permanent adhesive layer 53B which will have apertures or keys at operating keys, underside metallised reflective layer parts 55A, B (shown plain and with key-related deformations, respectively), and semi-permanent adhesive at 54, 56 to each face of the absorptive layer 53A.

It will be appreciated that, generally, references with differing first digits represent similar or equivalent provision according to their second digits.

CLAIMS

1. Radiation shielding (11) for a mobile telephone handset, comprising a radiation-absorptive material (13,23,33) and a radiation-reflective cover (15,25,35) which is applied over the radiation-absorptive material, the radiation-reflective cover in use covering handset operating keys whilst allowing required operation by touch.

2. Radiation shielding (11) according to claim 1, in which the radiation-absorptive material is incorporated in or within the casing of the mobile telephone handset (10).

3. Radiation shielding (11) according to claim 1, in which the radiation absorptive material (13, 23, 33) and the radiation-reflective cover (15,25,35) are layers of a laminated structure for affixing to the outer periphery (10F) of the mobile telephone handset (10).

4. Radiation shielding (11) according to claim 3 in which the radiation-absorptive layer is apertured (13K, 23K, 33K) in register with handset operating keys, the radiation-reflective cover extending over the aperture(s).

5. Radiation shielding (11) according to claim 4, further comprising spacers (49) in the aperture(s) in registration with handset operating keys when the radiation-absorptive layer is thicker than upstand of operating keys.

6. Radiation shielding (11) according to claim 5, in which the spacers (49) are attached to or integrated with the radiation-reflective cover.

7. Radiation shielding (11) according to any one of the preceding claims, in which the radiation-reflective cover (15,25,35) includes raised stud-like formations (25K) in registration with handset operating keys.

8. Radiation shielding (11) according to any one of the proceeding claims, in which the radiation-absorptive material (13,23,33) is non-uniformly distributed, being arranged to counter localised radiating components of the mobile telephone handset.

9. Radiation shielding (11) according to any one of the preceding claims, in which radiation-reflective cover (15, 25, 35) is transparent, at least in the vicinity of the handset operating keys.

10. Radiation shielding (11) according to anyone of the preceding claims, in which the radiation-reflective cover (15, 25, 35) is laminated, with one layer comprising a metallic coating.

11. Radiation shielding (11) according to claim 10, in which the metallic coating is of indium-tin oxide.

12. Radiation shielding (11) according to claim 10 or 11, in which another layer of the laminated radiation-reflective cover comprises a flexible plastics film (17).

13. Radiation shielding (11) according to claim 12, in which the flexible plastics film (17) is of about 150 microns thickness.

14. Radiation shielding (11) according to any one of the proceeding claims, in which the radiation-absorptive material (13, 23, 37) includes inclusions.

15. Radiation shielding (11) according to claim 14, in which the composition of the inclusion is selected from the group comprising metals, metal oxides, ferrites, carbon, boron, silicon, mica, ceramics, and rare earth elements.

16. Radiation shielding (11) according to claim 14 or 15, in which the form of the inclusions is selected from the group comprising particulate fibrous and flake-like.

17. Radiation shielding (11) according to claim 16, in which sizes for the inclusions range form about 45 microns to about 150 microns for particles, from about 5 microns to about 10 microns diameter by about 0.5 mm to about 1mm length for chopped fibres, and from about 0.0015 microns to about 0.004 microns for flake-like.

18. Radiations shielding (11) according to any one of the preceding claims, in which the radiation-absorptive material (13, 23, 33) comprises a foamed or expanded plastics material.

19. Radiation shielding (11) according to claim 18, in which the plastics material is of closed cell form, with cell sizes in the range 1mm to 10mm.

20. Radiation shielding (11) according to claim 18, in which the plastics material is of open cell form, with pore sizes in the range 0.01mm and 0.1mm.

21. Radiation shielding (11) according to any one of the preceding claims, further comprising adhesive to affix the radiation-reflective cover in position.

22. Radiation shielding (11) according to any one of the preceding claims, in which the radiation-reflective cover covers the face (10F) of the mobile telephone handset which in use, is opposite the user's head.

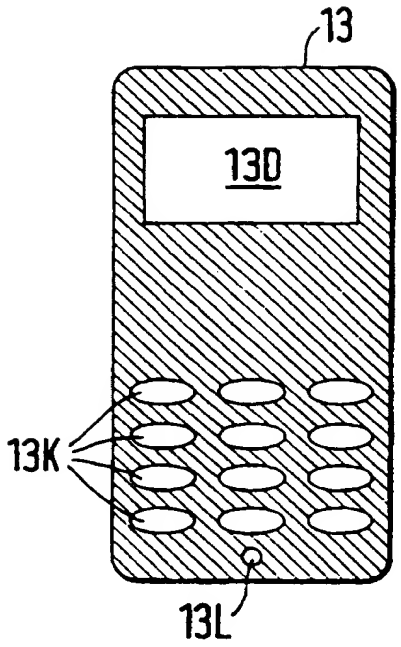

Fig. 1A

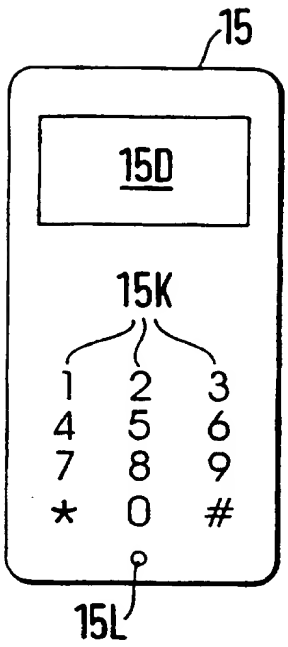

Fig. 1B

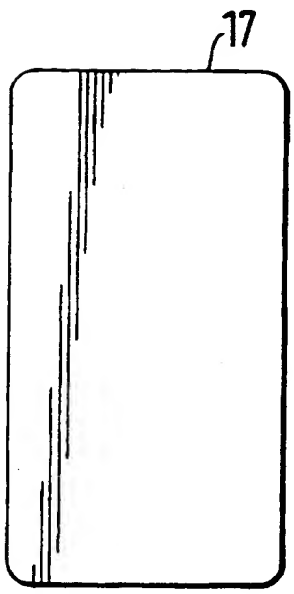

Fig. 1C

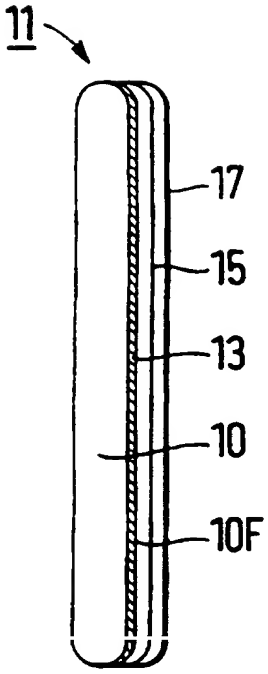

Fig. 1

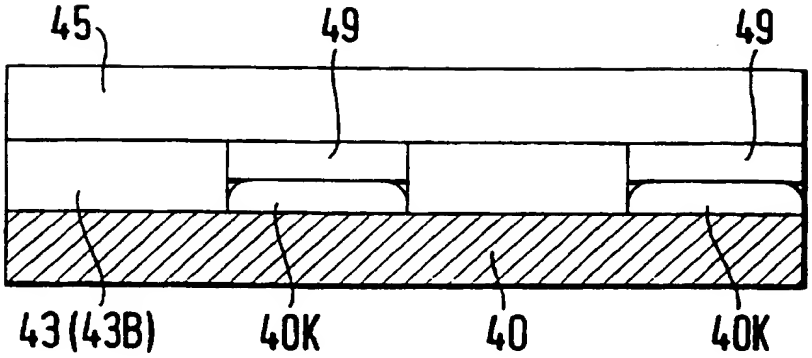

Fig. 4

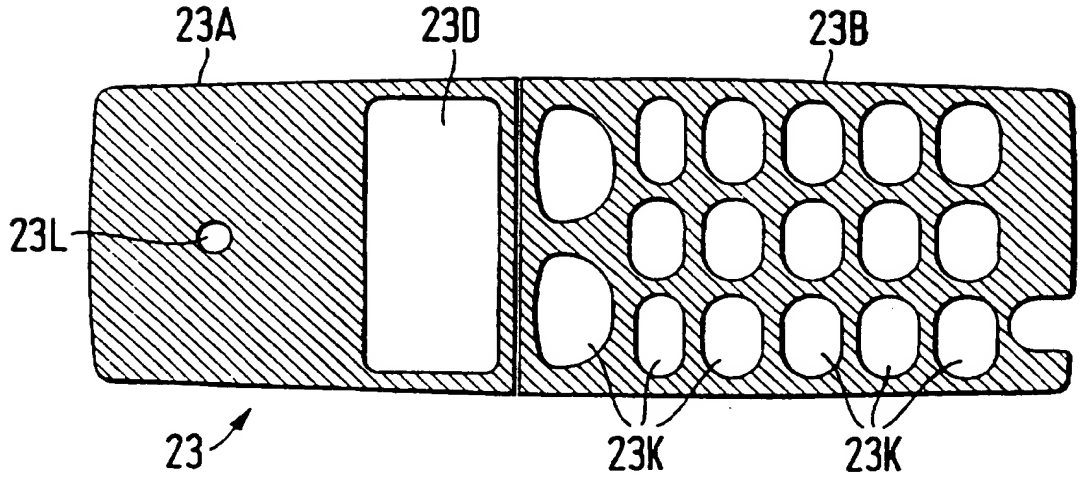

Fig. 2A

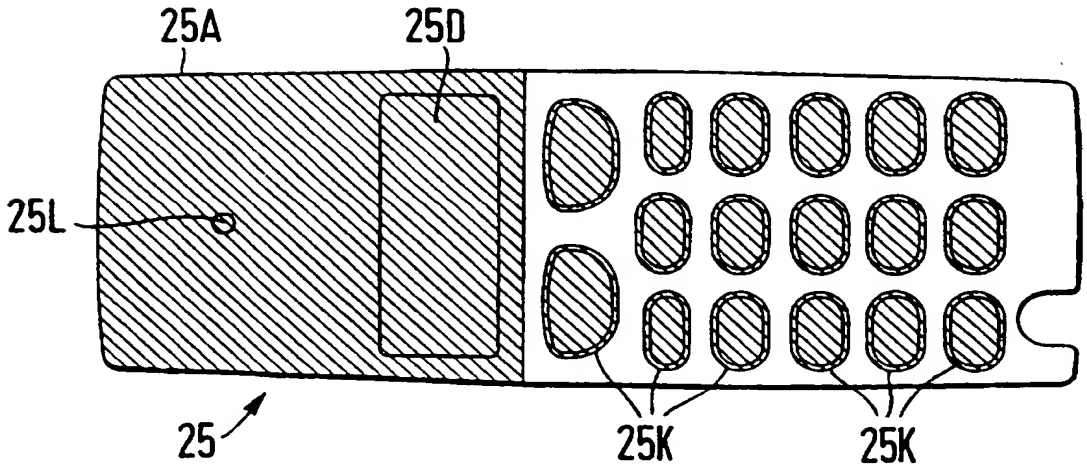

Fig. 2B

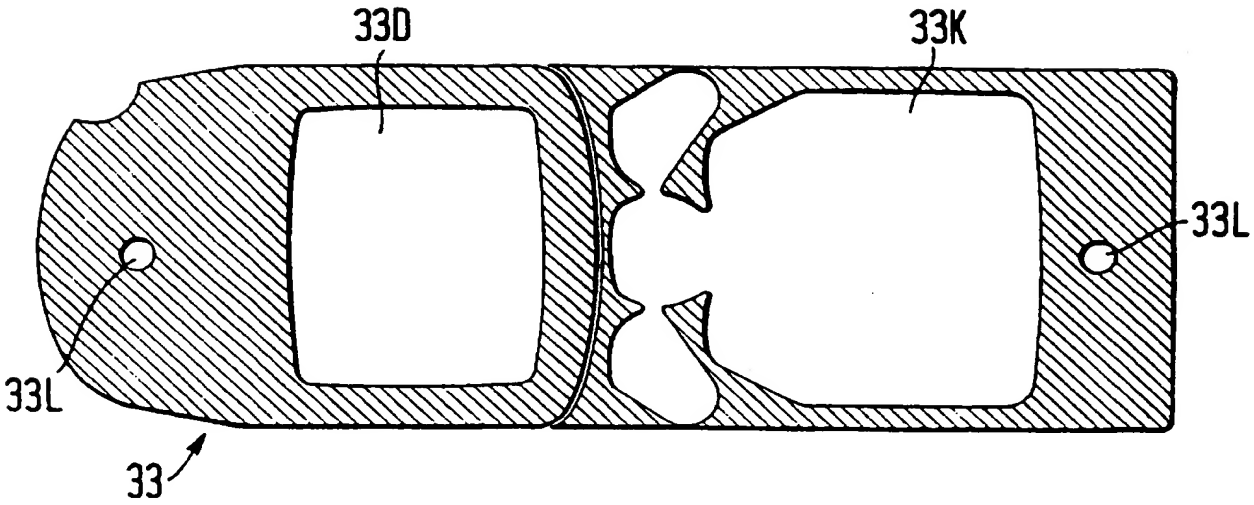

Fig. 3A

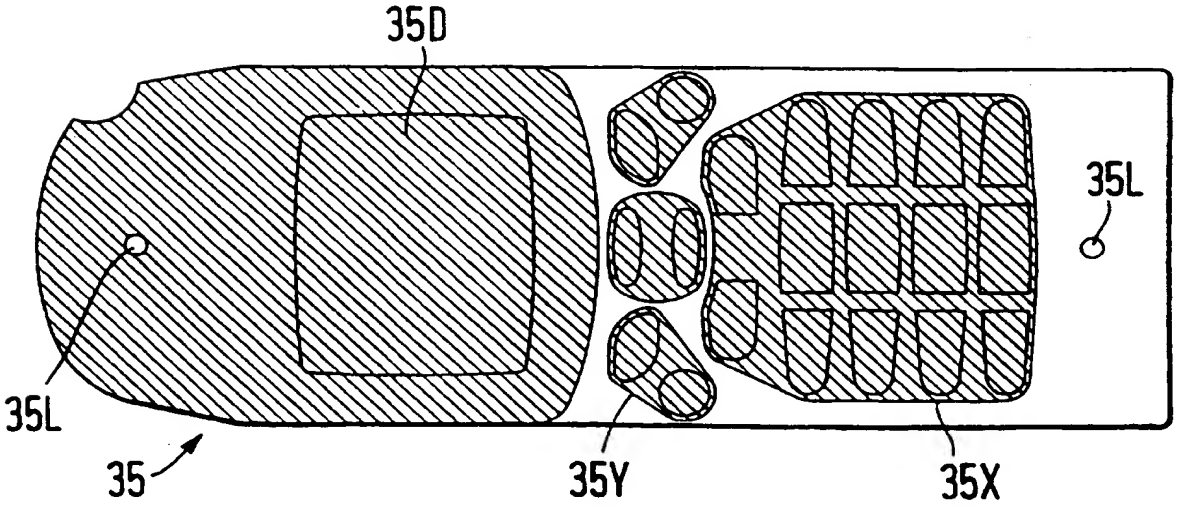

Fig. 3B

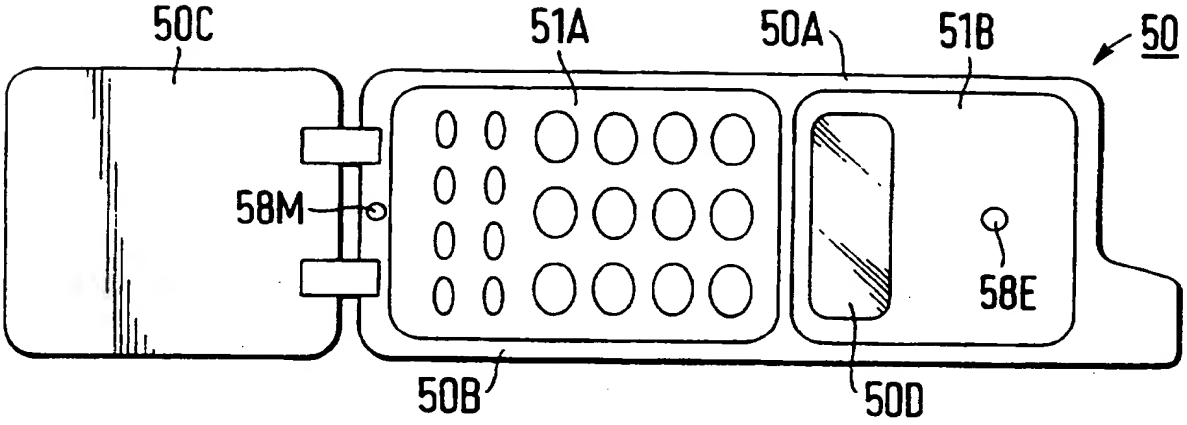

Fig. 5A

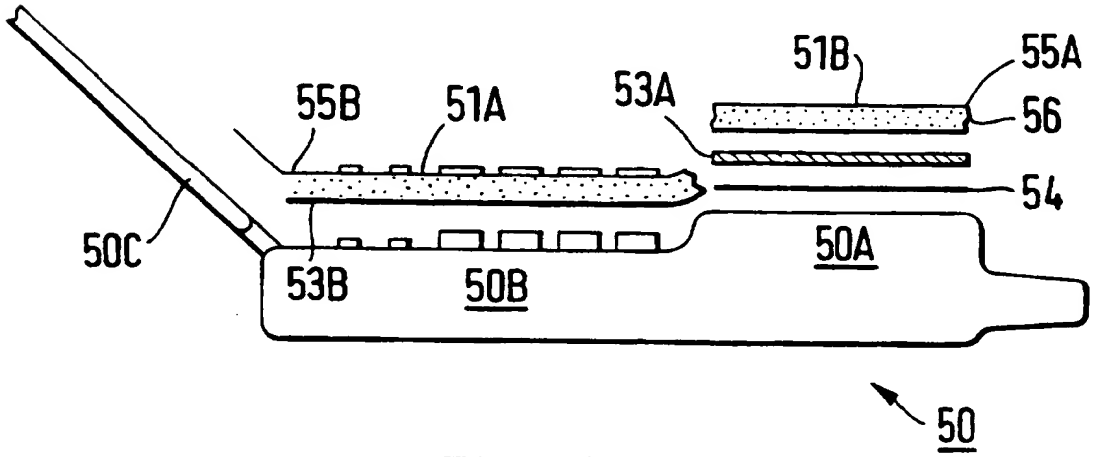

Fig. 5B

INTERNATIONAL SEARCH REPORT

Interna l Application No
PCT/GB 97/00853

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B1/38 H01Q1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 94 21054 A (WILSON LESLIE RONALD) 15 September 1994	1,3,9, 10,22
A	see abstract see page 2, line 3 - page 3, line 23 see page 7, line 10 - page 9, line 7 see figure 2 see figure 3	2,4,7,8, 11,12, 14,18,21

Y	PATENT ABSTRACTS OF JAPAN vol. 016, no. 570 (E-1297), 10 December 1992 & JP 04 220851 A (MITSUBISHI ELECTRIC CORP), 11 August 1992,	1,3,9, 10,22
A	see abstract	2,4,7,8, 11,12, 14,18,21

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
1 August 1997	18. 08. 97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	**Authorized officer** Lindhardt, U

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INTERNATIONAL SEARCH REPORT

Interna l Application No
PCT/GB 97/00853

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 31048 A (DANIELS JOHN J) 16 November 1995 see abstract see page 5, line 12 - page 6, line 19 see page 24, line 30 - line 37 see figure 1 see figure 6C see figure 19A -----	1-4,14, 15,21,22

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna[illegible]l Application No
PCT/GB 97/00853

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		CA 2157928 A	15-09-94
		EP 0688478 A	27-12-95
		FI 954207 A	03-10-95
		NO 953583 A	30-10-95
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		CA 2148355 A	29-09-94
		DE 4491705 T	07-12-95
		EP 0669060 A	30-08-95
		WO 9422235 A	29-09-94
		AU 2511195 A	29-11-95